ACTIVITY PATTERNS IN A COLONY OF PEAFOWLS (*PAVO CRISTATUS*) IN NATURE[1]

K. NAVANEETHAKANNAN[2]

(*With five text-figures*)

i) The activity patterns as regards the external environment of *Pavo cristatus* occupying an area at Nagamalai ridges near Madurai Kamaraj University campus and consisting of approximately 50 peafowls of either sexes were studied.
ii) Onset of activity of the first flyer from their roosting tree corresponds to the time of sunrise throughout the period of observation thus implicating the light as the chief synchronizing agent.
iii) Returning activity occurs around the time of sunset, and the phase relation (ψ end) is as precise as for emergence.
iv) Activity time is correlated with the duration of photoperiod Increase in photoperiod results in an increase in the duration of activity.
v) The value of light intensity and the movement of departure of the first flyer does not exhibit any systematic triggering light intensity threshold.

INTRODUCTION

Many field studies have been undertaken on birds and small mammals of temperate regions as regards their timings of activity in relation to environmental factors over the seasons (Voute *et al.* 1974, Daan and Aschoff 1975, Erkinaro 1972). Their activity rhythms are mainly regulated by light/darkness cycle of nature. Other extrinsic factors such as temperature (Hoffmann 1968), sound (Menaker and Eskin 1966, Gwinner 1966) and social cues (Marimuthu *et al.* 1981) and intrinsic factors such as hormones (Turek *et al.* 1976), can also eventually modify several such activity rhythms.

Daily beginning and end of activities, in day-active birds correspond to timings of sunrise and sunset respectively, and keep closer pace with them in temperate regions, (Daan and Aschoff 1975). Such systematic study, however, is not available for activity patterns of tropical birds. Day length varies only marginally in the regions closer to the equator. The day length, however, varies by about 1 h and 22 min over the seasons of the year at Madurai (lat. 9°58'N, long. 78°10'E). The present study describes the activity patterns of peafowls, *Pavo cristatus* and correlates them to environmental factors such as sunrise, sunset and photoperiod.

Terminology:

α — duration of activity
ψ — phase angle difference
ψ onset — Time interval between sunrise and onset of activity
ψ end — Time interval between sunset and end of activity
ψ midpoint — 1/2 (ψ onset + ψ end)

[1] Accepted September 1982.

[2] Department of Animal Behaviour, School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021.

Habitat description and study methods

The study area is located at the foothills of the Nagamalai ridge to the north of the Madurai Kamaraj University campus (lat. 9° 58′N, long. 78°10′E) and houses a colony of peafowl of *c.* 50. The ridge lies in the east-west axis and is approximately 10 km. the southern flank of which is a rain shadow. The habitat is surrounded by thick scrub jungle with rich bird and ground insect population. Water availability is scarce because of the rock surface of the habitat. Peafowls usually roost on the branches of *Acacia* spp. and on palmyra trees.

All day-watches were made from July 1980 until the end of March 1981 in that area. The observer was positioned away from these roosting sites and noise and movement were kept to a minimum. The time of beginning of activity of the peafowl was recorded from a distance using a pair of binoculars. Values of light intensity were measured using an AEG lux meter at the time of onset of flight activity of peafowls from the roosting tree. Recordings of ambient temperature, rainfall and wind speed were obtained from the meteorological station of the Department of Animal Behaviour, School of Biological Sciences, Madurai Kamaraj University. Sunrise, sunset data were obtained from the tables of 'Nautical Almanac'.

Results

Pattern of emergence activity, based on the number of peafowls which fly from the roosting trees with time is typically a bell shaped curve as shown in Fig. 1. On the contrary the pattern of end of foraging activity (number of peafowls roosting vs time) indicates that the peak of roosting occurred *en masse.* (Fig 1)

The time of beginning of activity of birds from the roosting trees was related to the time of sunrise as shown in Fig. 2. The beginning of activity time varied between 0544 h (July) to 0640 h (March) during the period of investigations. This closely parallels the sunrise time

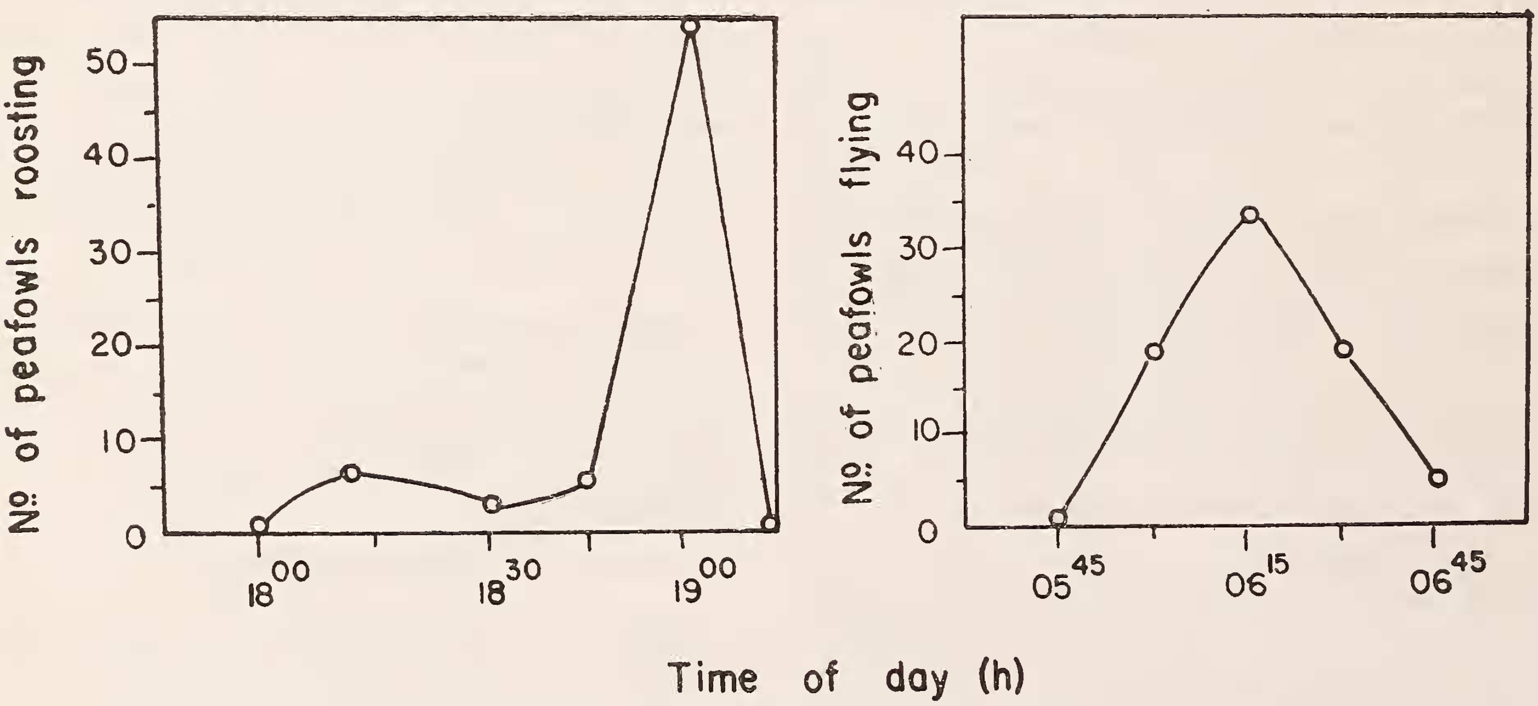

Fig. 1. Onset of foraging flight and end of activity are plotted as a function of time. The peak of onset of foraging activity is bell shaped. The roosting (end of activity) occurred *en masse* and vocalizations were frequent.

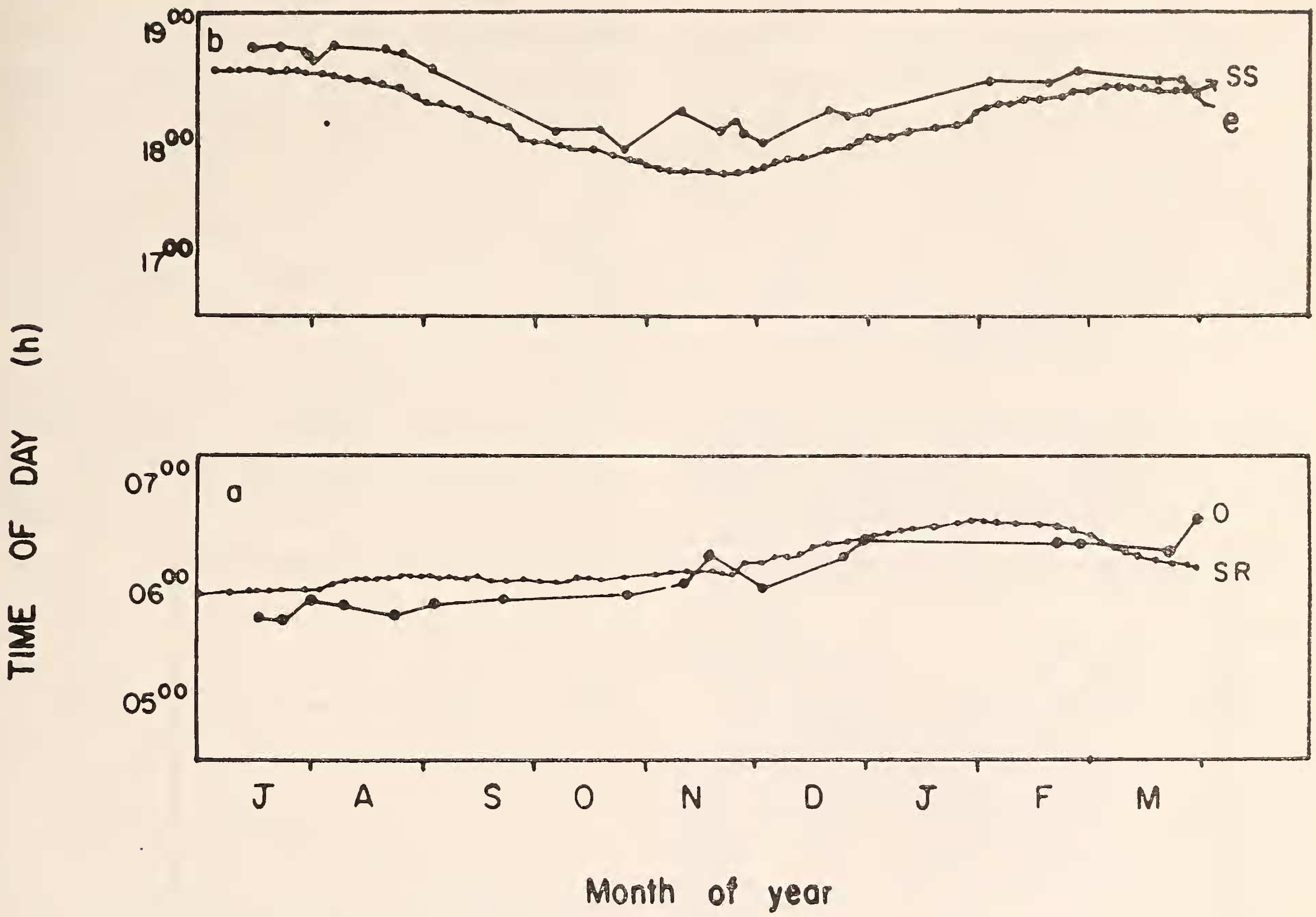

Fig. 2. (a) Field data on time of onset of activity of a colony of *Pavo cristatus*.
Foraging flight from the roosting tree corresponds to the time of sunrise.
(b) The end of activity of the bird corresponds to the time of sunset.
Ordinate: Hour of day.
Abscissa: Month of year.

which varied between 0600 h and 0640 h. It is a common practice in circadian literature to relate the timings of onset and end of activity of diurnal animals to characteristic phase points of the daily sunrise and sunset. This phase angle difference, ψ onset, was calculated as the time difference between sunrise and the onset of activity (Fig. 3.)

Environmental variables other than light had a minor influence on the time of onset of activity. There was no evidence that the onset of activity was influenced by temperature since the mean temperature during the study period varied between 20°C and 37°C.

The peafowls vocalize while roosting. The birds started returning to the roosting site from 1700 h. The end of activity closely paralleled the time of sunset. For example, the time of end of activity varied between 1759 h and 1859 h over the study period which roughly paralleled the sunset time 18^{12} to 18^{42} h.

The phase angle difference ψ_e was calculated as the time difference between sunset and the end of activity of the last roosting bird. The ψ onset and ψ end values roughly mirror-image. (Fig. 3).

Activity time:

The analysis of activity time as a function of photoperiod (sunlight duration) shows that activity follows the seasonal variations in light dark ratio (Fig. 4). Activity time is positively correlated with the duration of the photoperiod. Increase in photoperiod resulted in an increased activity time.

Discussion

The day to day variations on the timings of onset of activity and end of activity may be considered to be indicative of the precision of the clock underlying and governing such activities. (Aschoff *et al.* 1972). The clock would be more precise if the onset of activity is nearer to sunrise: by the same token the end of activity to sunset in diurnal animals (Erkinaro 1972). In our study of birds there is seasonal variation in the onset of activity which ranges from 05^{44} to 06^{40} indicating a parallel seasonal shift with the time of sunrise from 0600 to 0640 h. Similar seasonal shift of end of activity is observed which keeps pace with the progression of the time of sunset. Aschoff and Wever (1962) have formulated that day to day variations in the time of activity onset are smaller

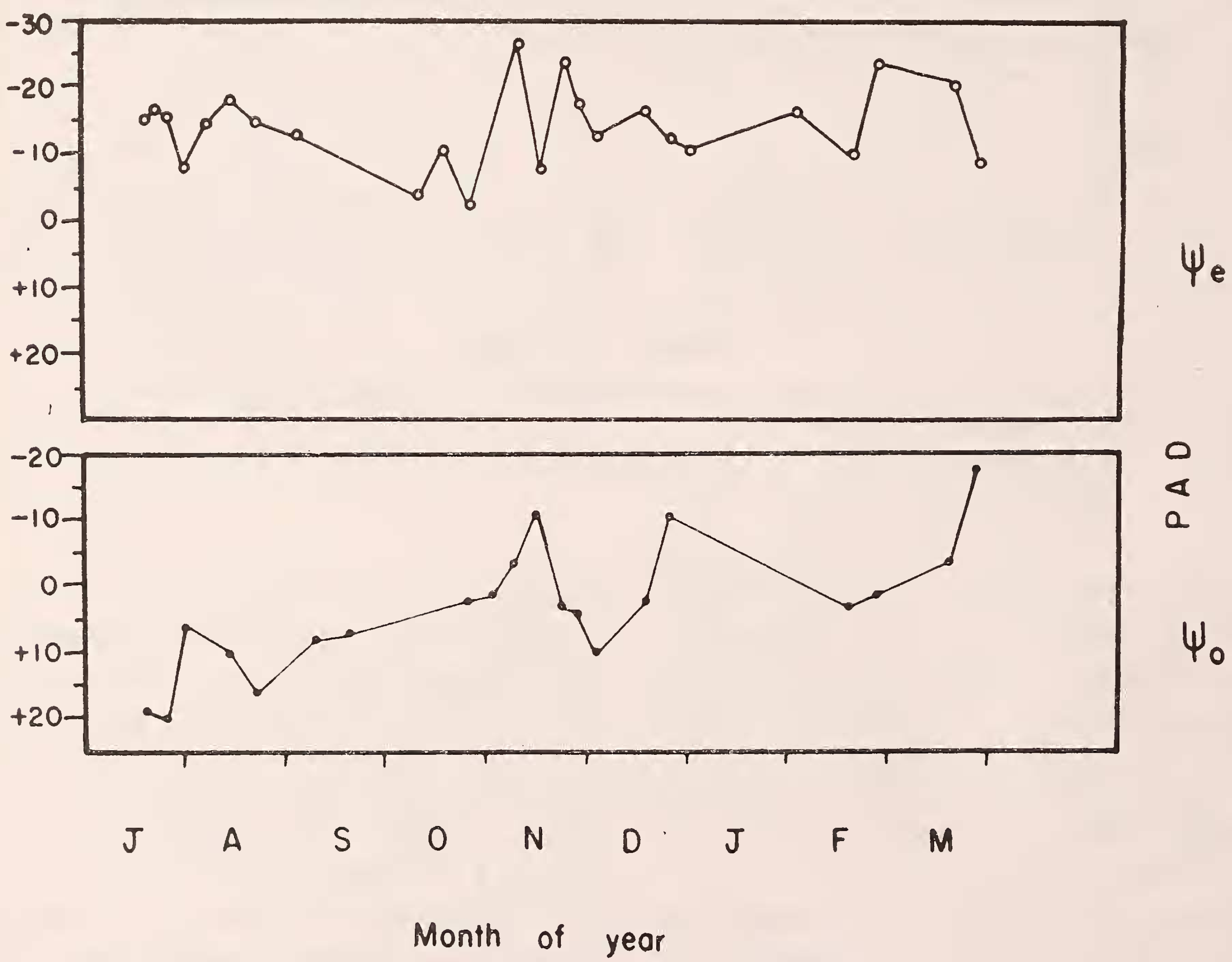

Fig. 3. Seasonal changes of onset and end in *Pavo cristatus*. The seasonal variations in ψ_o and ψ_e roughly mirror image.
Ordinate: ψ_o and ψ_e values in minutes.
Abscissa: Month of year.

than variations in the end of activity. Our peafowls exhibited no such day to day variations of onset relative to end of activity. Thus the data derived from the field study partly violates

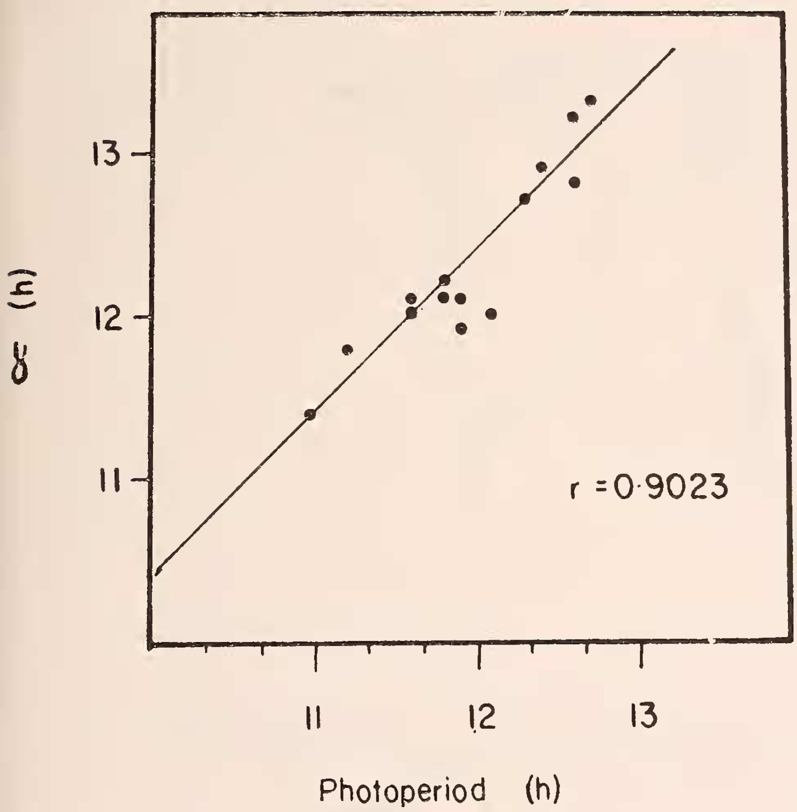

Fig. 4. Activity time is correlated with the duration of photoperiod. Activity time increases with increasing photoperiod.
Ordinate: Activity time (h).
Abscissa: Duration of photoperiod (h).

the Aschoff and Wever (1962) generalizations.

Activity onset in day active birds is usually at higher light intensities than end of activity (Daan and Aschoff 1975). The statement was based on the large number of studies compiled and supported by most of the analyses made by Daan and Aschoff in captive birds and mammals. In the present observations it was found that the peafowls begin and end their activity at similar light intensities. Such differences as are noted between temperate and tropical birds may be due to differences in the inherent sensitivity of the animals to light intensities, to differences in climatic conditions and differences incident upon latitudinal factors and in the physiological status of the animals related to general living conditions. According to Aschoff (1965) the best way to measure appropriate phase relation in diurnal animals is to compare the midpoint of activity with the midpoint of day light. In Fig. 5 the activity midpoint has been plotted against season: ψ midpoint decreases as the daylength becomes shorter and increases as it grows longer. This observation accords with the seasonal rule of Aschoff (1964) and Daan and Aschoff (1975) which can be claimed to account for many diurnal animals.

The graph giving the duration of daily activity versus the photoperiod can be described as S-shaped in all species studied so far both in nature and in captivity. In our study activity time of birds paralleled the duration of photoperiod.

Changes of α occurred (which lead to S-shaped curve) only in those seasons with photoperiod shorter than 5 h and longer than 18 h which do not occur in our study area. However, the duration of α is a linear function of photoperiod.

Acknowledgements

I am grateful to Prof. M. K. Chandrashekaran for critically reviewing the manuscript. I am also indebted to Dr. R. Subbaraj, and Dr. G. Marimuthu for their help in preparing the manuscript.

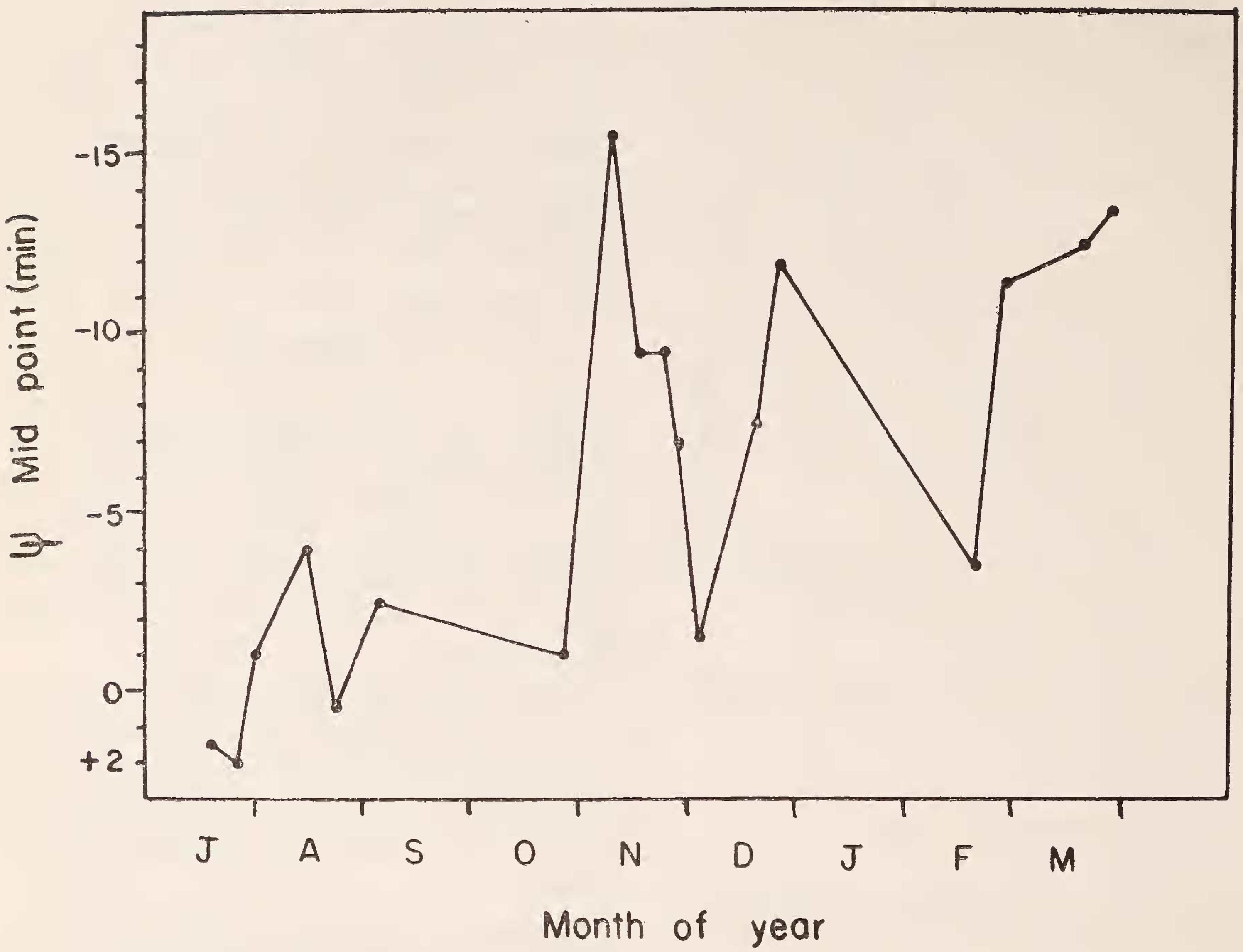

Fig. 5. Seasonal changes in the midpoint of activity (ψ midpoint). ψ midpoint decreases as the day length becomes shorter and increases as it grows longer
Ordinate: ψ midpoint in minutes.
Abscisca: Month of year.

References

Aschoff, J. (1964): Die Tagesperiodik licht-und dunkelaktiver Tiere. *Rev. Suisse Zool. 71*: 528-558.

———— (1965): The phase angle difference in circadian periodicity. In: 'Circadian Clocks' (ed Aschoff, J.), North Holland, Amsterdam. pp-262-276.

Aschoff, J. & Wever, R., (1962): Beginn und Ende der taeglichen Aktivitaet freilebender Voegel. *J. Orn, 103*: 2-27.

Aschoff, J., Daan, S., Figala, J. & Muller, K. (1972): Precision of entrained circadian activity under natural photoperiodic conditions. *Naturwiss 6*: 276-277.

Daan, S., & Aschoff, J. (1975): 'Circadian rhythms of locomotor activity in captive birds and mammals: their variations with seasons and latitude. *Oecologia 18*: 269-316.

Erkinaro, E. (1972): Precision of the cireadian clock in Tengmalm's Owl (*Aegolius funereus* L.) during various seasons. *Aquillo* (*oulu*) *13*: 48-52.

Gwinner, E. (1966): Periodicity of a circadian rhythm in birds by species specific song cycles (Aves, Fringillidae), *Carduelis spinus, Serinus serinus. Experientia, 22*: 765-766.

HOFFMANN, K. (1968): Synchronization der circadianen aktivitaetsperiodik von Eidechsen durch Temperaturcyclen verschiedener Amplitude. *Z. Vergl. Physiol. 58*: 225-228.

MENAKER, M., & ESKIN, A. (1966) : Entrainment of circadian rhythms by sound in *Passer domesticus. Science, 154*: 1579-1581.

MARIMUTHU, G., RAJAN, S., & CHANDRASHEKARAN, M. K. (1981): Social entrainment of circadian rhythm in the flight activity of the microchiropteran bat (*Hipposideros speoris*). *Behav. Ecol. Sociobiol. 8*: 147-150.

TUREK, F. W. MCMILLAN, J. P., & MENAKER, M. (1976): Melatonin alters the circadian rhythm of activity of sparrows. *Science, 194*: 1441-1443.

VOUTE, A. M., SLUITER, J. W., & GRIMM, M. P. (1974): The influence of the natural light dark cycle on the activity rhythm of pond bats (*Myotis dasycneme* Boie 1825) during summer. *Oecologia. 17*: 221-243.